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APPLICATION FOR UNITED STATES PATENT

DATA MODELING METHOD AND SYSTEM

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DATA MODELING METHOD AND SYSTEM

RELATED APPLICATION

The present application claims the benefit of U.S. Provisional Application Serial No. 60/165,132, filed November 12, 1999.

BACKGROUND OF THE INVENTION

The present invention relates generally to data modeling, and more specifically, to computer based knowledge representation.

Advances in computer technology have provided many different methods for storing, organizing, accessing, and manipulating a variety of data, yet a fundamental problem in computer-based knowledge representation remains to be addressed. The problem is that knowledge is inherently unbounded, while computerized representations tend to be constrained, both by modeling techniques and by physical quantities such as memory and storage.

For example, conventional data systems such as relational databases typically provide linking between records stored in separate tables to create representations of processes. One drawback to these database systems is that they fail to provide a comprehensive indirect means to link together information. Conventional systems ignore the special requirements for creating knowledge

from an assembly of informational items where the relationships between the informational items do not fall within the strict relational model. Furthermore, only those linking relationships between tables of records defined during the design phase are allowed. If there is a need to create a new linkage between a different set of records, the entire database must undergo a redesign, which has associated costs. Similarly, there is no easy way to introduce new data tables into the database without requiring a redesign of the underlying data structure, software program that runs it, or user interface.

Distributed (network-based) representation offers the potential for pushing back the physical limits to representation, but poses additional challenges, the main ones being data synchronization and information "noise". Distributed representation does not eliminate the need for solving the problem of overly constrained models, and additionally, it introduces the problem of insufficiently constrained models. The Internet today is filled with both of these. There are thousands of specialized sites which have abrupt boundaries around the information they provide access to; each site has a learning curve, and crossing the boundaries must be done "by hand". Then there are sites which organize information in either such a tightly structured way or such a completely free-form way that one must know exactly where to look, or else resort to a text-based search where one hopes to get lucky with a manageable set of possible "hits."

SUMMARY OF THE INVENTION

A computer implemented method for presenting information is disclosed. The method includes providing at least one database comprising a plurality of data models, each of said data models containing a representation of data in a space and time relationship. The method further includes presenting a selected data model such that the information can be viewed based on spatial relationships or time relationships.

The method may further include providing a plurality of links between two or more of the data models. The links are attached at related events located on either side of the linked data models. Each of the links may be assigned a link model that provides additional detail on the reason for the existence of the link.

The data model may be for a historical event, person, or a geographic location, for example.

Sub a2 ~~In another aspect of the invention, a computer implemented method for creating a data model includes creating a database of events, each event having a common theme, and connecting the events in a space and time relationship to form a data model. The data models are linked to other data models based on at least one common event in each of the data models.~~

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A computer implemented method of the present invention for accessing and viewing information contained within a data model generally comprises selecting the data model for retrieval from a database, viewing the data model based on spatial or time relationships, and selecting a linked data model for viewing.

In yet another aspect of the invention, a computer program product generally comprises computer code that provides at least one database comprising a plurality of data models. Each of the data models contains a representation of data in a space and time relationship and are linked to other data models in a hierarchical relationship via link models. The product further includes computer code that presents a selected data model such that the information can be viewed based on spatial relationships or time relationships. A computer readable medium is provided to store the computer code.

In another aspect of the invention a method for modifying an existing data model generally comprises creating a database of events and sub-events. Each even pertains to the existing data model. The method further includes connecting the events in a space and time relationship to build a modified data model. The modified data model is linked to other data models through one of the events to add specific context to links between data models.

The above is a brief description of some deficiencies in the prior art and advantages of the present invention. Other features, advantages, and embodiments of the invention will be apparent to those skilled in the art from the following description, drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic illustrating a data modeling system of the present invention.

Fig. 2 is a schematic illustrating an example of a computer system that can be utilized to execute software of an embodiment of the present invention.

Fig. 3 is a system block diagram of the computer system of Fig. 2.

Fig. 4 is a schematic illustrating the spatial, temporal, and hierarchical aspects of a worldline model of the present invention.

Fig. 5 is a schematic of a worldline necklace of the data modeling system of the present invention.

Fig. 6 is a block diagram of a worldline model.

Fig. 7 is a diagram illustrating contents of a frame of the worldline model of Fig. 6.

Fig. 8 illustrates an exemplary screenshot that depicts a browser displaying multiple views of data related to the Statue of Liberty.

Fig. 9 illustrates an exemplary screenshot that depicts a set of worldlines in a 3D Earth-centered timeline.

Fig. 10 is a flowchart illustrating a process for creating a worldline model.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE INVENTION

The following description is presented to enable one of ordinary skill in the art to make and use the invention. Descriptions of specific embodiments and applications are provided only as examples and various modifications will be readily apparent to those skilled in the art. The general principles described herein may be applied to other embodiments and applications without departing from the scope of the invention. Thus, the present invention is not to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features described herein. For purpose of clarity, details relating to technical material that is known in the technical fields related to the invention have not been described in detail.

The present invention provides for distributed knowledge representation for use in knowledge-enabled computer applications. A method and system of the present invention may be used in applications such as encyclopedias, genealogies, or discographies, for example. The method may also be used in analysis tools for history activities such as economic development, conflict resolution, and demography. It is to be understood that these applications are only provided as examples and that the method and system described herein may be used for other applications without departing from the scope of the invention.

The system is used to represent data through a flexible combination of space and time relationships combined with hierarchical, semantic relationships. The data is represented in a model referred to in the following description as a "worldline" (based on a term from particle physics which refers to the path of an elementary particle through space and time). The term worldline refers to a track through space and time of any entity that can be thought of in historical terms. The term worldline may refer to the historical entity itself, people, places, or things, as described below.

Fig. 1 illustrates an exemplary system for modeling data in a worldline model. The data may be entered or viewed at a computing device 20 that is connected to a network 21 such as the Internet or an intranet. The computer 20 includes a worldline browser/editor 25 that interfaces with the network 21 to create or view data represented in a worldline model. The worldline data may be stored in a plurality of databases 27 that may be accessed, for example, via one or more websites on the Internet. It is to be understood that the system of Fig. 1 is only one example of a system that may be used to create or view worldline models. For example, a stand-alone computer may contain worldline databases or may be connected through a group of computers through a local area network (LAN) so that a group of users may share or create interrelated worldlines, as described below.

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~~Fig. 2 illustrates an example of a computer system that may be used to execute software of an embodiment of the invention. The computer system 20 includes a display 22, screen 24, cabinet 26, keyboard 28, and mouse 30 which may include one or more buttons for interacting with a GUI (Graphical User Interface). Cabinet 26 houses a CD-ROM drive 32, system memory 42 and a hard drive 44 (see Fig. 3) which can be utilized to store and retrieve software programs incorporating computer code that implements aspects of the invention, data for use with the invention, and the like. Although CD-ROM 34 and floppy disk 35 are shown as exemplary computer readable storage media, other computer readable storage media including tape, flash memory, system memory, and hard drive may be utilized. Additionally, a data signal embodied in a carrier wave (e.g., in a network including the Internet) may be the computer readable storage medium.~~

Fig. 3 shows a system block diagram of computer system 20 used to execute software of an embodiment of the invention. Computer system 20 further includes subsystems such as a central processor 40, system memory 42, fixed storage 44 (e.g., hard drive), removable storage 46 (e.g., CD-ROM drive), display adapter 48, sound card 50, transducers 52 (speakers, microphones, and the like), network interface 54, and printer/fax/scanner interface 56. Other computer systems suitable for use with the invention may include additional or fewer

subsystems. For example, computer system 20 may include more than one processor 40 (i.e., a multi-processor system) or a cache memory.

The system bus architecture of computer system 20 is represented by arrows 60 in Fig. 3. However, these arrows are only illustrative of one possible interconnection scheme serving to link the subsystems. For example, a local bus may be utilized to connect the central processor 40 to the system memory 42 and display adapter 48. Computer system 20 shown in Figs. 2 and 3 is only one example of a computer system suitable for use with the invention. Other computer architectures having different configurations of subsystems may also be utilized.

The data modeling system of the present invention allows data to be viewed concurrently in space and time relationships, as well as in hierarchical relationships. As illustrated schematically in Fig. 4, a worldline may be viewed in one dimension 70 as a timeline and in another dimension 72 as a series of events organized in a spatial relationship. For example, a worldline for a person may be viewed along timeline 70, starting with the birth of the person and ending with his death. Events in the timeline such as the birth of a son, can also be viewed in the context of space based on the location of the birth. Thus, an event 74 on the timeline 70 may also be located on line 72 with reference to its geographical

location. As further described below, the worldlines may also be viewed as a hierarchical list 76.

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~~Fig. 5 illustrates a set of linked worldlines 80 which may be referred to as~~ a world necklace. A block diagram of a worldline representational model is shown in Fig. 6. Each worldline 80 within the world necklace includes a plurality of frames 82 and events 84. A link represents a formal assertion that a given worldline is connected to one or more other worldlines in a certain manner. More specifically, the link is designated as either an uplink 83 or a downlink 85, which assigns a hierarchical direction to the connection. Each link is assigned a link ~~model 88, which represents an assertion about why the link is being made.~~

Link models 88 provide a level of abstraction, higher than is seen in conventional data representations, for the subjective act of categorization. For example, in a conventional data model Abraham Lincoln may belong to the category president, whereas in the worldline model the categorization is performed by links. The Abraham Lincoln worldline is up-linked to a president worldline via a link model whose meaning may be, for example, performing a role or function. The link model 88 may also be considered a hint mechanism since a link can be understood without its link model, just not as easily. Link models are a relatively small set of agreed-upon types of connections recognized by the creator or creators of a worldline-based model.

The following are examples of potentially effective groups of link models: 1) existence of an individual, work of art/artifact, appointed/elected person, form of life, work, language, geological feature, geopolitical entity, people, technological invention, legal/financial entity, cultural/politcal/scientifc movement or idea, physical/chemical quantity, cultural/political/social event, place, occupation or career, group/roster, defining action/role, or astrophysical entity; 2) inclusion or membership in a geopolitical entity, people, legal/financial entity, cultural/political/scientific movement or idea, physical/chemical quantity, group or roster; or 3) performance of a work of art or a defining action or roll, pursuit of an occupation or career, residence in a particular place, settling of an area, participation in a cultural, political, or social event, or representation in a work of art or artifact.

Fig. 7 illustrates contents of frame 82. The frame 82 preferably includes a date, position, extension, and orientation, and may include additional data such as pointers to images. The date provides a location in time (e.g., day, month, year). The position specifies a location in a 3D coordinate system (e.g., longitude, latitude, and altitude relative to an Earth worldline). The extension is an indication of extent using a 3D shape type (e.g., major axis, minor axis, and height). The orientation provides an attitude adjustment within the 3D coordinate system. The frame 82 is basically a 3D snapshot of a worldline. A worldline can thus be represented in space and time by one or more frames. The 3D snapshot is

an arbitrarily complex piece of data that at a minimum specifies a three-dimensional position, orientation, and bounding volume in a coordinate system, relative to a reference worldline, at some point in time. For example, a frame for the worldline "Guggenheim Museum" may be a large 3D CAD model, but also contain a much simpler specification for a box that approximates the size and shape of the museum on a specified date, and places it at a predetermined position on a map of New York City (or on a globe of the Earth) on that date.

An event is a segment of a worldline, which may also be assigned links and frames. Its purpose is to capture meaningful ways of sub-dividing a worldline, along with assertions that links between worldlines occur at specific points during the life of the worldline. Events preferably have the same structure as worldlines, including the ability to contain sub-events.

Examples of worldlines include Abraham Lincoln, the American Civil War, Lincoln's Gettysburg Address, and the Lincoln Memorial. The more general categories of president, war, speech, and statue, respectively, are also worldlines that can be described in historical terms. The Abraham Lincoln worldline may be represented as an individual timeline (e.g., birth to death) with frames placing life-sized models of Lincoln at various spatial locations Additionally, the worldline may include links to other related worldlines either directly or attached to events along the timeline, such as the places where Lincoln

was born, where he grew up, where he was educated, and where he died, or the speeches he wrote, or the laws he signed or vetoed. Thus, a person viewing a worldline may easily jump back and forth among worldlines in the model either by following links, or by using spatial or temporal proximity.

As further examples, the American Civil War worldline may be viewed as a map that changes over time as battles are fought and won or different states join the war. The map can be confined to the ground, whereas worldlines for modern wars may include details of airplane battles and radio communication. Within the map, the battles, the states, the people, etc., are all potential worldlines as well. The worldline for Lincoln's Gettysburg Address may include reference to its physical and historical origin, an original draft or drafts, and future reproductions, each of which has a physical and historical background. The worldline for historical monuments such as the Lincoln Memorial may include details on the structure such as construction history, or initial drawings.

The worldline model may be implemented on computing device 20 as a collection of text-files written in a modeling language and distributed over a network, as described below. In one embodiment, the present invention may be used to access information via the Internet through a browser. The worldline model may also be implemented as binary objects that can be read, written, and

manipulated by specialized software. It is to be understood that other implementations may be used without departing from the scope of the invention.

A modeling language referred to as HRML (Historical Reality Modeling Language) may be used along with software (e.g., worldline browser/editor) that reads and writes files written in the modeling language to present the modeled knowledge for viewing and editing. This allows large, complex worldline models to be organized into file-based projects and distributed over networks. HRML may be implemented on HTTP (Hypertext Transfer Protocol), for example. It may be designed to conform to the XML (Extensible Markup Language) standard, or may use a separate protocol. HRML preferably includes ID numbers that are used to uniquely identify worldlines, events, frames, and link models. Textual names, in one or more languages, are used to help identify what is being represented, but the entities are allowed to exist independent of their names. Distributed knowledge authoring is enabled by dispensing unique ID ranges to worldline creators and attaching these IDs to the various aspects of the model (worldlines, events, frames, and link models). The creators are then able to incorporate and leverage off of each other's worldline models.

HRML also serves to formally define and embody the worldline model, and allow features of a distributed system to evolve. For example, the minimum data content of frames may be formally defined as follows: ten numbers may be

used to identify a basic size and location in space and time (time, plus three sets of 3D coordinates for position, orientation, and extension), and ten more numbers may be used to provide a certainty factor for the first ten, and a reference to a basic shape, type and coordinate system.

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~~Additionally, frames may contain standard Internet URL's (Uniform~~ Resource Locator). Just as names add missing semantic information for worldlines, events, and link models (which are defined within the model only by their interconnections), a frame URL can point to a picture, or other more sophisticated data source, and thereby help lend meaning to the minimal data content required by the model. An HRML file may also contain a list of URL ~~pointers to other HRML files.~~

The worldline browser/editor may be used to create, edit, view, and query world necklaces. World necklaces may be built in a session-based manner by reading distributed HRML data files and merging their contents. The world necklaces may be stored persistently and may incorporate new data from subsequent sessions. The browser/editor may also be used to navigate through world necklaces in a visual manner, both hierarchically and through space and time. Complex queries may be performed on world necklaces, using both worldline concepts and traditional text-based methods. The browser/editor may

also be used to save skeleton views of world necklaces, which are later filled in with events or linked to other worldlines.

Fig. 8 illustrates an exemplary screenshot of a worldline browser/editor displaying multiple views of data related to a Statue of Liberty worldline model. These views all utilize an outline style of display appropriate to the hierarchical nature of worldline necklaces. The first box 90 is a listing of a set of worldlines defined or referenced in a single HRML file. (Question marks indicate missing dates.) The second box 92 displays a list of uplinks, downlinks, frames, and events for one of those worldlines, "Statue of Liberty". The list is partially expanded to reveal three specific events, placing the conception, construction, and dedication of the Statue of Liberty in time. Two of those events are expanded further to reveal worldlines and link models participating in uplinks to those events. Two of the linked worldlines are people, one is a political body, and another is a material. Boxes 96 and 98 include uplinks, downlinks, frames, and events for worldlines that are linked to the Statue of Liberty worldline, revealing that Alexandre Eiffel, of Eiffel Tower fame, was also involved in the building of the Statue of Liberty, though he was not the sculptor, who was his less well-known countryman, Frederic-Auguste Bartholdi, from Alsace-Lorraine. This exploration can continue indefinitely, as all worldlines can become jumping-off points of their own.

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~~Fig. 9 shows a view called a session map populated with worldlines for~~ sixty-one cities, and focused in on the location of Albuquerque. As the user downloads HRML files, worldlines of all kinds take their place on the map. This type of view can be used to navigate through a worldline necklace in space and time. The user my "fly" over worldlines for cities or rivers, and zoom in to see what worldlines exist at ground level, such as buildings, people, or works of art. The user may position the viewer precisely with the spatial controls, and may jump through time as well. The user may also "play" the worldline necklace like a movie, watching worldlines come in and out of existence, grow, change appearance, or move around. The user may also select worldlines in the viewer to explore in a hierarchical view, or conversely, select worldlines in the list to cause ~~the viewer to bring them into view.~~

A viewer may view the information along a timeline in a forward direction, or go backwards in time through history. The viewer may move through time quickly or slowly and stop to view additional detail or other worldline links of interest. Also, since the worldlines exist in a hierarchical structure of uplinks and downlinks, the user can jump from one worldline to another. The user may also query the database or network of databases for worldlines that meet any combination of space or time relational criteria, or link based criteria. The present invention, thus, allows users to search through

information simultaneously in space and time, a hierarchical manner, and query based navigation.

Fig. 10 is a flowchart illustrating a process for creating a worldline model. The user first registers with a web site that provides tools for creating worldline models and receives, for example, a set of unique 64-bit ID numbers which will be used to uniquely identify all of the worldlines, events, frames, and link models the user may create (step 100). The creater uses authoring tools to create a set of HRML files that can be exchanged via the Internet and which integrate with the world necklaces created by other authors. For example, the user may first create an HRML file called "family1" and save it on his computer's hard drive or storage on the network (step 102). With the intention of creating a family tree world necklace, the user creates three worldlines, one for the user, another for the user's father, and a third for the user's mother (step 104). At step 106, each person's birthday is entered as a frame. The worldlines are then connected using an uplink command (step 108). For each linked worldline, the user specifies a link model (step 110). For example, the link between a parent and child may have the link model "existence of an individual." The authoring tool may include a list of link models to choose from or a new link model may be created. The user then enters information such as dates and places for a family tree world necklace. Additional events such as weddings, funerals, jobs held, schools attended, or places lived may be added to the worldlines. Each event may include a reference

to different types of media such as photographs or movies. The worldline is then linked up with other worldlines (step 114). At any point in this process, the browser may be used to view the model. The browser may be used, for example, to navigate hierarchically up and down the tree of links and visualize family members appearing at appropriate spots on the globe and time in history.

Another method for creating a world necklace is to use a wizard type of authoring tool. This method may be used for specific types of world necklaces or worldline models. For example, a family tree world necklace wizard is used to lead the user through a series of questions, present various charts to fill in, and offer optional areas to explore. The wizard includes built-in knowledge of different kinds of links that constitute genealogical relationships, including intricacies such as how to model adoption, name change, divorce, or inheritance. The wizard may also be used to link with other existing worldline models.

As can be observed from the foregoing, the system and method of the present invention provide numerous advantages over conventional data modeling systems. For example, the present invention provides a computer based knowledge representation method that allows for space, time, hierarchical, and query-based navigation.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

Although the present invention has been described in accordance with the embodiments shown, one of ordinary skill in the art will readily recognize that there could be variations made to the embodiment without departing from the scope of the present invention. Accordingly, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.